9 RISK MANAGEMENT

The DOE's risk management is forward-looking, structured, informative, and continuous. The key to successful risk management is in early planning, unbiased assessments, and aggressive execution. Good planning enables an organized, comprehensive, and iterative approach for identifying and assessing the risk and handling options necessary to successfully carry out the acquisition of a materiel asset. To support these efforts, the six-step risk process (Figure 9-1) should be performed as early as possible in the life cycle to ensure that critical technical, schedule, and cost risks are identified and/or addressed as part of the Program/project planning, execution, and budget activities.

PMs should continuously update acquisition and risk assessments and tailor their management strategies accordingly. Early information provides data that helps when preparing a MNS, draft acquisition strategy, AS, and RMP as well as assisting in contract placement/ execution. As a project progresses, new information improves insight into risk areas, thereby allowing the development of effective handling strategies. The net result promotes executable projects.

Effective risk management requires involvement of the entire IPT and may also require help from outside experts knowledgeable in essential risk areas (e.g., technology, design, safety, quality, manufacturing, logistics, schedule, and cost). Overall, the risk management process should include hardware, software, the human element, and integration issues. Outside experts may include representatives from the user, laboratories, contract management, test, program and industry. Users, including all essential participants are to be part of the assessment process so that an acceptable balance among performance, schedule, cost, and risk can be reached. A close relationship between the Government and industry, and later with the selected contractor(s), promotes an understanding of project risks and assists in developing and executing risk management efforts.

Successful risk management programs should have the following characteristics:

- Feasible, stable, and well-understood user RDs (F&ORs).
- A close relationship with user, industry, and other appropriate participants.
- A planned and structured risk management process, integral to the acquisition process.
- An AS consistent with risk level and risk-handling strategies (Section 4.9).
- Continual reassessment of project and associated risks.
- A defined set of success criteria for all performance, schedule, and cost elements, e.g., APB thresholds (Chapter 8).

- Metrics to monitor effectiveness of risk-handling strategies (Chapter 10).
- Effective test, checkout, and Startup/Turnover plans.
- Formal documentation

To ensure that a risk management program possesses the above characteristics, PMs should follow the guidelines below.

- Assess project risks, using a structured process, and develop strategies to manage risks throughout each acquisition phase.
- Identify early and intensively manage design parameters that critically affect cost, capability, or readiness.
- Use technology demonstrations/modeling/simulation and aggressive prototyping to reduce risks.
- Use test and evaluation as a means of quantifying the results of the risk-handling process.
- Include industry and user participation in risk management.
- Use developmental test and evaluation when appropriate.
- Establish a series of "risk assessment reviews" to evaluate the effectiveness of risk handling against clearly defined success criteria.
- Establish the means and format to communicate risk information and to train participants in risk management.
- Prepare an assessment training package for members of the IPT and others, as needed.
- Acquire approval of accepted risks at the appropriate decision level.
- In general, management of software risk is the same as management of other types of risk and techniques that apply to hardware projects are equally applicable to software intensive projects.

9.1 Process

Risk management follows a six-step process of risk awareness, identification, quantification, handling, impact determination, and reporting and tracking (Figure 9-1).

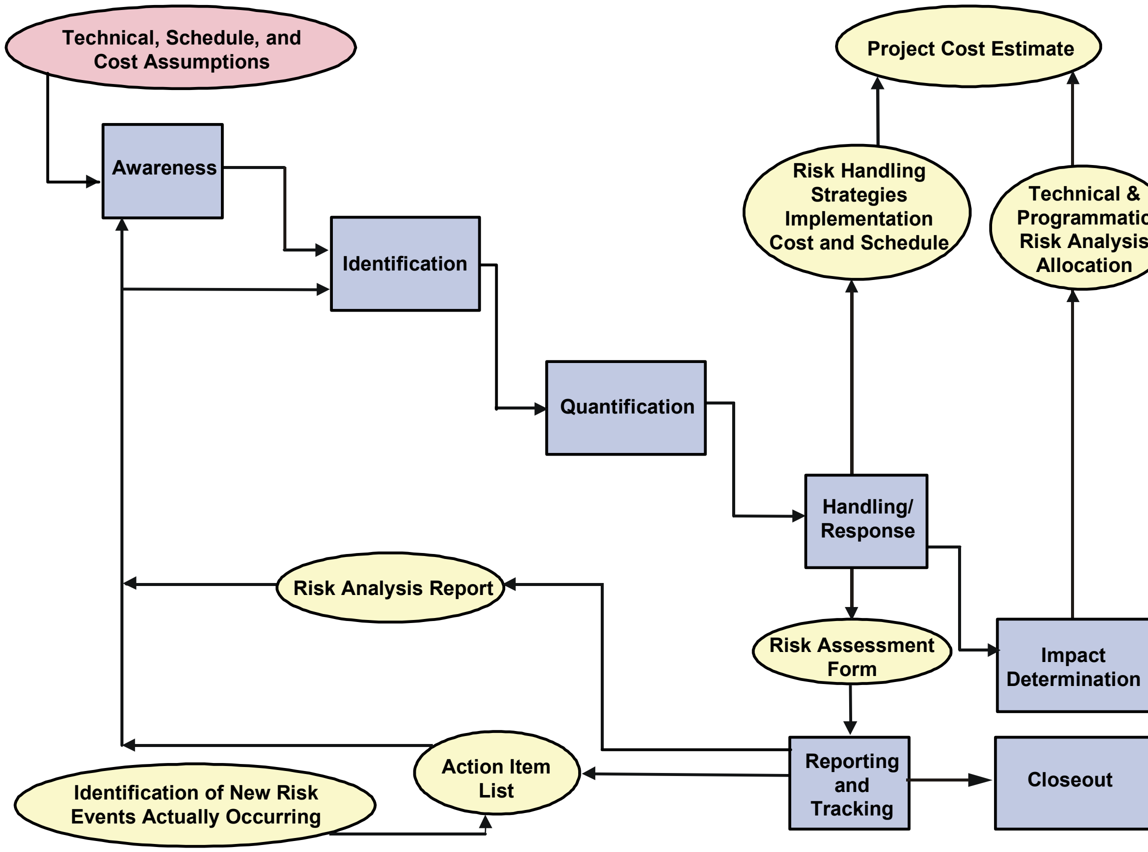

Figure 9-1. Risk Management Functional Flow Diagram

Risk management activities (subsequent to those at project pre-acquisition planning) are the responsibility of individuals identified in the RMP. These responsibilities do not change unless the RMP is revised.

The overriding objective of the risk management process is to identify probable project risks and implement actions that will mitigate the impact of the identified risks. Early risk and hazards identification and analyses should be "built-in" to the project during conceptual design to establish a foundation for further project development, refinement, and execution.

Although each risk management strategy depends upon the nature of the system being developed, research reveals that good strategies contain the same basic processes and structure shown in Figure 9-1. The application of these processes varies with acquisition phases and the degree of system or project definition; all may be integrated into the overall acquisition management function. The elements of the structure and its implementation are discussed in detail in the Practice on Risk Management.

Risk is a measure of the potential inability to achieve overall project objectives within defined cost, schedule, and technical constraints. The two components of risk include the *probability/likelihood* of failing to achieve a particular outcome, and the *consequences/ impacts* of failing to achieve that outcome.

Risk events are elements of an acquisition effort that are assessed to determine the level of risk, such as things that could go wrong for a project or system. The events should be defined to a level that an individual can comprehend the potential impacts and causes. For example, a potential risk event for a turbine engine could be turbine blade vibration. There are series of events that contain risk. These events can be selected, examined, and assessed by subject-matter experts.

The relationship between the two components of risk-probability and consequence/impact is complex. To avoid obscuring the results of an assessment, the risk associated with an event should be characterized in terms of its two components: probability and consequences. As part of the assessment, there is a need for documentation containing the supporting data and assessments.

9.1.1 Risk Awareness

The PM should develop a RMP. This plan identifies the scope of the project's risk definition and defines interfaces with other entities, projects, facilities, and organizations; delineates the methodology that will be used to identify and quantify or assess risks; assigns personnel and/or organizational responsibilities; and provides risk tracking and closeout mechanisms. For smaller projects, the RMP may be included in the PEP. The RMP is maintained throughout the life of a project.

Each project should perform acquisition risk assessments on projects having a TPC greater than $5M. These assessments may be performed prior to each Critical Decision, documented, and the results included in the CD approval request package. Based upon the results of these assessments, the IPT can then develop and implement risk reduction and mitigation strategies. The assessment results can also be used to develop and implement risk-based acquisition strategies and are fully integrated with the overall RMP.

In developing acquisition risk assessments, the PM and the IPT should consider the following categories (as a minimum):

- Project and scope definition.
- Environment, safety, and health.
- Acquisition and contract management.
- Project management.
- Funding and budget management.
- Technology and engineering management, including project required research or technology development.
- Schedule development.
- Cost estimate development.

- Project interfaces and integration requirements.
- Safeguards and security issues and requirements.
- Policy and stakeholder issues.
- Project location and site conditions.
- Legal and regulatory issues.

9.1.2 Risk Identification

Risk identification is initiated through risk screening. Screening is performed against an established set of trigger questions, identifies significant potential risks associated with a project, and focuses on the ability to design and execute the proposed project and to operate the resultant facility or property.

The process identifies "potential" project risks (e.g., cost, schedule, and technology), by preparing clear-risk statements with corresponding bases flagged in the risk-screening step. When defining risks, the level of detail is commensurate with the stage of the project. For example, during project pre-acquisition planning, new technology is being considered. In describing this risk, it can have applicability not only to the technology area but also to the potential resources, design complexities, testing, and interfaces among systems and components within the project scope and with external entities or procurements.

The degrees to which these details are applicable to the project are unknown at the pre-acquisition planning stage. However, for risk purposes, they can be "expected" and considered in risk evaluation and be identified as potential cost and schedule impacts even if there is only one risk identified. This is sufficient, since an early objective of risk analysis is to establish sufficiently accurate scope, schedule, and cost bases to ensure that the project can be successfully implemented.

In the risk identification process, the difference between an initial risk assessment and subsequent risk assessments is the level of detail expected as a project matures. As more information becomes available, previously identified risks are divided into discrete risks to better facilitate handling, tracking and resolution of both risks and associated action items.

9.1.3 Risk Quantification

Risk quantification follows the process documented in the RMP. Using one of the methods described in the Practice on Risk Management, quantification is based on a combination of risk probability and consequence. If the initial process is revised, the new process is reflected in the revised RMP.

9.1.4 Risk Handling/Response

For each identified risk, the risk-handling strategy is reviewed to ensure that necessary action items are being developed and implemented. For each new risk identified, a risk-handling strategy is developed.

Several tools exist to mitigate risks, including the following:

- Cost. Involves risk adjusted estimates/baselines, VM, and constant cost reduction/cost control activities.
- Schedule. Involves risk adjusted schedules/activities, long-lead procurements, workarounds, make/buy decisions, and early initiation of some activities.
- Technical. Involves technology development plans, laboratory tests, VM, and demonstrations, bench scale tests, and pilot-plant tests.

9.1.5 Risk Impact Determination

Each identified project risk has potential impact(s) on the project. Impacts should be documented. The potential for project impacts can be minimized by:

- Incorporating handling strategies intended to minimize the impact of an identified risk into the project baseline, and adjustment of the proposed baseline range estimate (technical schedule, cost) to reflect this incorporation.
- Developing a risk-based probabilistic cost estimate to reflect the anticipated cost associated with potential risks.
- Incorporating schedule allowance into the integrated project schedule to reflect anticipated delays associated with potential risks.

For smaller projects without an integrated schedule, scheduled delays can be converted into equivalent dollars based on expenditures per unit delay in time. This can be included in the project cost baseline. A risk activity recognizes that this practice serves to identify the cost of the delay. The process does not contribute to an improved forecast of the project end date. Where appropriate, a formal gap analysis may be completed to evaluate the risk between project requirements and proven technologies.

9.1.6 Risk Reporting, Tracking, and Closeout

Risk reporting involves documenting risk identification, risk quantification, risk handling strategies, impact determination, and risk closeout.

Risk tracking involves monitoring action items from risk-handling strategies/responses, identifying a need to evaluate new risks, and reevaluating changes to previous risks.

When a project performs an acquisition risk assessment the findings/results need to be included in the CD request-for-approval package. When preparing this package, the PM may include a discussion of each of the topics identified in the Practice. Based upon the project complexity and other factors, the results of the risk assessments performed by the project may be specifically selected for review by DOE-OMBE (OECM and PA&E). This review, if performed, would be done in support of the other required reviews that are associated with the various critical decisions.

Risk closeout is assigning risk associated action items to a responsible individual and identifying a completion date. Completion dates are tracked and each action item status updated until closeout. The action item tracking system is commensurate with the size and complexity of the project. This process follows the system prescribed in the RMP. If deviations prove necessary, they are shown in a revision to that plan.

Detailed guidelines for risk-handling strategies are provided in the Practice on Risk.

9.2 Risk Discussion

Implicit in the definition of risk is the concept that risks are future events, i.e., potential problems, and that there is uncertainty associated with the project if these risk events occur. Therefore, there is a need to determine, as much as possible, the probability of a risk event occurring and to estimate the consequence/impact if it occurs. The combination of these two factors determines the level of risk. For example, an event with a low probability of occurring, yet with severe consequences/impacts, may be a candidate for handling. Conversely, an event with a high probability of occurring, but with consequences/impacts which do not directly affect a project may be acceptable and require no handling.

To reduce uncertainty and apply the definition of risk to acquisition programs, PMs should be familiar with the types of acquisition and project risks, understand risk terminology, and know how to measure risk. These topics are addressed in the next several sections.

9.2.1 Characteristics of Acquisition Risk

Acquisition projects tend to have numerous, often interrelated, risks. They are not always obvious; relationships may be obscure; and they may exist at all project levels throughout the life of a project. Risks are everywhere; in the early planning; in support provided by other Government agencies; in mission need risk assessment; and in prime contractor processes, engineering and manufacturing processes, and technology. The interrelationship among risk events may cause an increase in one because of the occurrence of another. For example, a slip in schedule for an early test event may adversely impact subsequent tests, assuming a fixed period of test time is available.

Another important risk characteristic is the time period before a future risk event occurs; because time is critical in determining risk-handling options. If an event is imminent, the PM may have to resort to crisis management. An event that is far enough in the future to allow management actions may be controllable. The goal is to avoid the need to revert to crisis management and problem solving by managing risk up front.

An event's probability of occurrence and consequences/impacts may change as the development process proceeds and information becomes available. Therefore, throughout the development phase, PMs should reevaluate known risks on a periodic basis and examine the project for new risks.

9.2.2 Acquisition Program/Project Processes, Risk Areas, and Risk Events

Acquisition risk includes all risk events and their relationships to each other. It is a top-level assessment of impact to the project when all risk events at the lower levels of the project are considered. Acquisition risk may be a roll-up of all low-level events; however, most likely, it is a subjective evaluation of the known risks by the PM, based on the judgment and experience of experts. Any roll-up of project risks should be carefully done to prevent key risk issues from “slipping through the cracks.” Identifying risk is essential because it forces the PM to consider relationships among all risks and may identify potential areas of concern that would have otherwise been overlooked. One of the greatest strengths of a formal, continuous risk management process is the proactive quest to identify risk events for handling and the reduction of uncertainty that results from handling actions.

A project has continuous demands on its time and resources. It is, at best, difficult, and probably impossible to assess every potential area and process. To manage risk, PMs should focus on the critical areas that could affect the outcome of their projects. WBS product and process elements and systems engineering and manufacturing processes should capture most of the significant risk events. Risk events are determined by examining each WBS element and process in terms of sources or areas of risk. Broadly speaking, these sources generally can be grouped as cost, schedule, and performance, with the latter including technical risk. Following are some typical WBS risk areas:

- Requirements Definition. The sensitivity of the project to uncertainty in the system description and requirements except for those caused by threat uncertainty.
- Environment, Safety and Health. The controls, sensitivities, and impacts that the project has or will have to be dealt with to be effective.
- Design. The ability of the system configuration to achieve the project’s engineering objectives based on the available technology, design tools, design maturity, etc.
- Test and Evaluation. The adequacy and capability of the test project to assess attainment of significant performance specifications and determine whether the systems are operationally effective and suitable.
- Modeling and Simulation. The adequacy and capability of these tools to support all phases of a project using verified, valid, and accredited modeling and simulation tools.
- Technology. The degree to which the technology proposed for the project has been demonstrated as capable of meeting project objectives.
- Logistics. The ability of the system configuration to achieve the project’s logistics objectives based on system design, maintenance concept, support system design, and availability of support resources.
- Safeguards and Security. The sensitivity of the project to the uncertainty that may result from safeguards and security requirements.
- Production. The ability of the system configuration to achieve the production objectives based on the system design, manufacturing processes chosen, and availability of manufacturing resources such as facilities and personnel.
- Concurrency. The sensitivity of the project to uncertainty resulting from combining or overlapping life cycle phases or activities.

- Capability of Developer/Contractor. The ability of the developer/contractor to design, develop, and build the system. The contractor should have the experience, resources, and knowledge to produce the system.
- Cost/Funding. The ability of the system to achieve the project's life cycle cost objectives. This includes the effects of budget and affordability decisions and the effects of inherent errors in the cost estimating technique(s) used (given that the technical requirements were properly defined).
- Management Interface/Integration**.** The degree to which program/project plans and strategies exist and are realistic and consistent. The IPT should be qualified and sufficiently staffed to manage the project.
- Funding and Budget Management. The sensitivity that the project has to funding and budget changes.
- Schedule**.** The adequacy of the time allocated for performing the defined tasks, e.g., development, production, etc. This factor includes the effects of programmatic schedule decisions, the inherent errors in the schedule estimating technique used, and external physical constraints.
- Stakeholder, Legal, and Regulatory. The sensitivity and degree to which these areas will impact the planning, performance, schedule and cost of the project.

There are additional areas, such as manpower, systems engineering, quality, etc., that are analyzed during project development. The PM strives to pick the most appropriate areas, while still being inclusive, but not to the point of diluting the effort. The PM may consider these areas for early assessment since failure to do so could cause dire consequences/impacts in the project's latter phases.

9.2.3 Risk Management Plan

The RMP is the road map that tells the Department and contractor team within the risk environment how to effectively implement a new materiel asset that meets the MNS. The key to writing a good plan is to provide the necessary information so the IPT knows the objectives, goals, and the PM's risk management process. Since it is a map, it may be specific in some areas, such as the assignment of responsibilities for Government and contractor participants and definitions, and general in other areas to allow users to choose the most efficient way to proceed. For example, a description of techniques that suggests several methods for evaluators to use to assess risk is appropriate, since every technique has advantages and disadvantages depending on the situation.

The Practice on risk contains an example of a RMP. A summary of the format is shown in Figure 9-2.

Introduction Project Summary Definitions Risk Management Strategy and Approach Risk Management Process and Procedures Risk Awareness Risk Identification Risk Quantification Risk Handling Risk Impact Determination Risk Reporting and Tracking

Figure 9-2. A Risk Management Plan Outline/Format

9.2.4 Risk Assessments and Cost and Schedule Estimates

Much of the discussion has been on the overall program/project risks. However, every project has to also effectively address risk within the individual estimates and schedules. For example, project "estimates" assess the risks within the cost estimate boundaries and evaluate the confidence in the elements that make up the estimate. Since every one of the many parts that make up an estimate is subject to some uncertainty, management needs to determine what the effect of the uncertainty surrounding each of the parts has on the total estimate and eventually at the TPC level. A Monte Carlo simulation technique, utilizing the probabilistic determination method, is typically employed on projects and yields the probability of an overrun or under run of a project's cost at various levels of allocations.
A model of the cost estimate is constructed, addressing all the cost components that make up the estimate, excluding the contingencies (i.e., Estimate Allocation, Technical and Programmatic Risk Assessment Allocation, and Schedule Allocation) which will be subsequently determined. This model represents and reflects the summary logic and approach utilized in preparing the cost estimate. It lists the various cost components of the project, such as labor cost, material cost, equipment cost, indirect/overhead cost, escalation cost, etc. These are known as "terms" in the model. Each cost component has a dollar value, which is its "weight" in the model. Elements that make up and affect each "term" are also listed. These are known as "variables" in the model. Typical "variables" that are addressed in the model include:

- Scoping
- Quantification
- Labor installation unit rates
- Labor productivity factors (location and work conditions may modify the labor installation unit rates)
- Labor costing rates

- Material pricing
- Equipment pricing
- Subcontract pricing
- Escalation rates
- Indirect/overhead rates.

An example of the “variables” that make up and affect the “term” “craft labor cost” is shown in Figure 9-3.

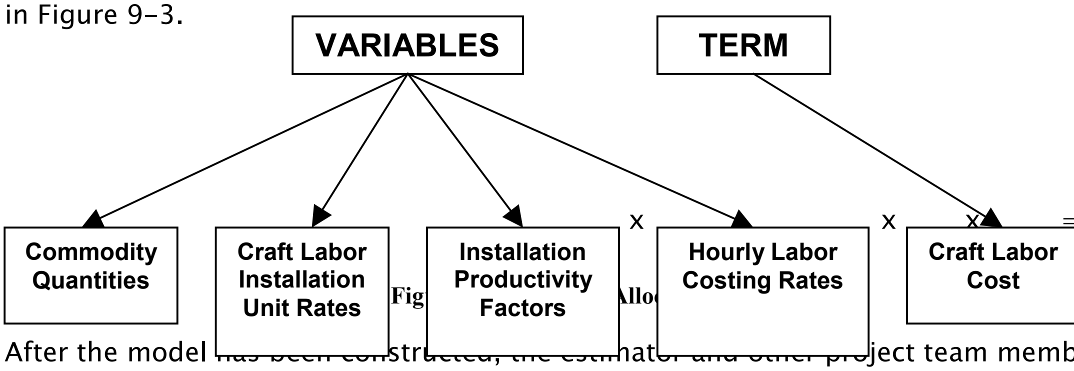

Fig... Allo...

After the model has been constructed, the estimator and other project team members estimate the confidence levels for each “variable”. This constructs a probability curve for each “variable”.

A Monte Carlo simulation computer software program is employed which uses a series of searches, sorts, and iterative logic routines to evaluate the data in the model. Utilizing a Monte Carlo simulation technique and the probability distribution of each “variable”, a variable value is obtained by drawing randomly from the variable’s probability distribution. In a similar manner, selections are made for each variable value from its respective distribution. This set of variable values is then substituted into the model and the first sample value of the dependent variable (TPC) is computed. Subsequent values of the dependent variable are obtained by drawing a large number of sets of activity values (e.g., 1,000 to 2,000 passes through the model). A probability distribution of the TPC is then produced. This information will yield an analysis of the relative risk and probable odds of overrunning or under running the projects estimated cost.

Outputs from Monte Carlo simulation software may consist of reports and graphs that address:

- Total risk allocation versus probability of overrun
- Probability distribution
- Relative contribution of variables
- Variable distribution versus allocations contribution
- Mean and standard deviation.

This information is used by management as a decision-making tool in determining the APB, and for contracting and setting the Contract Budget Baseline (CBB).